

Global Emissions Inventory Activity (GEIA) Overview

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ABSTRACT

The Global Emissions Inventory Activity (GEIA) has provided scientifically sound, policy-relevant global emissions inventories to the science and policy communities since the early 1990s. These global inventories are used to assess past, present and future global atmospheric chemistry, air quality and climate change. GEIA is a major activity of the International Global Atmospheric Chemistry (IGAC) Project, a core project of the International Geosphere-Biosphere Program. The GEIA Center located at www.geiacenter.org is the virtual data distribution and communications hub for GEIA. Details regarding GEIA and its plans for the future, all of the available data and project descriptions, and other news and outreach activities can be found at the Center. Over two dozen inventories, all provided on a 1 by 1 degree format over the world, are currently available. Plans for updating and expanding GEIA inventories to provide more spatial, temporal and chemical scope are underway. Over 300 users and developers are part of the GEIA E-mail network. Others are encouraged to join this international community and provide recommendations for future data and outreach activities.

INTRODUCTION

The Global Emissions Inventory Activity (GEIA) has provided scientifically sound, policy-relevant global emissions inventories to science and policy communities since the early 1990s. These inventories are used to assess past, present and future global atmospheric chemistry, air quality and climate change.

GEIA is a major activity of the International Global Atmospheric Chemistry (IGAC) Project, a core project of the International Geosphere-Biosphere Program. IGAC is a volunteer network of hundreds of scientists in more than 30 countries working together to coordinate and stimulate efforts to measure, understand and predict changes in global atmospheric chemistry over the next century. IGAC activities are dedicated to understanding this complex system through a combination of observation, theory, and laboratory and modeling studies.

GEIA's work cuts across and contributes to all of IGAC's other activities. The GEIA inventories provide a scientific foundation for policy initiatives designed to address urgent environmental issues such as global warming, stratospheric ozone depletion, acid precipitation and biological damage (Graedel et al, 1993). As these issues continue to become more pressing, GEIA has entered a new phase of revitalization, growth and enhanced responsiveness to an expanding user community.

This paper describes GEIA and its activities, summarizes available data, discusses plans for enhancing the GEIA data bases, and welcomes recommendations for future data and outreach activities from the user communities.

OVERVIEW

Organization and Guiding Principals

GEIA includes several hundred scientists all over the world, working together to create current and reliable data bases. Many of these scientists are involved in other IGAC activities. GEIA's work is guided by Co-Conveners Derek Cunnold of the Georgia Institute of Technology (USA) and Jos Olivier of RIVM, the Netherlands National Institute of Public Health and the Environment. Paulette Middleton, RAND (USA) directs the GEIA Center, the hub of data distribution and communication, located at <www.geiacenter.org>. Cunnold, Olivier and Middleton work closely with an international coordinating committee, including Carmen Benkovitz, Brookhaven National Laboratory (USA), Gregg Marland, Oak Ridge National Laboratory (USA), Ann McMillan, Atmospheric Environment Service (Canada), Jozef Pacyna, Norwegian Institute for Air Research and Trevor Scholtz, ORTECH Corporation (Canada).

GEIA was created in 1990 to develop and distribute global emissions inventories of gases and aerosols emitted into the atmosphere from natural and anthropogenic (human-caused) sources. The long-term goal is to develop inventories of all trace species that are relevant for global atmospheric chemistry. As with all IGAC activities, GEIA tries to include all interested parties on a volunteer basis. Emissions inventories experts from individual countries, supported by local organizations, conduct their own research while maintaining contact through a network of communications and participation in periodic meetings. The GEIA forum allows participants to discuss their work and to draw on combined expertise of their fellow members. This coordination of efforts ensures that results of their work are compatible and can be combined with a minimum of effort.

Inventory development is carried out through individual projects, each of which is composed of scientist from around the world. More than two dozen projects currently are addressing emissions for all major greenhouse gases and aerosols. Prior to becoming a GEIA data base, the inventory and its documentation must undergo thorough peer review. Each GEIA data base is accompanied by documentation and references to scientific publications that describe the effort.

GEIA's operations are organized around four key working principles:

1. GEIA's goal is to produce emissions inventories for all species of interest on a 1 degree by 1 degree global grid and on a country-by-country basis.
2. GEIA inventories are accompanied by assessment of their degree of uncertainty as well as a comparison with results of top-down global or regional budget studies, if available.
3. GEIA seeks to provide comprehensive information for each data base, including:

- sectoral information
- natural source, if appropriate
- temporal variation, at least by season/month
- historical emissions, as a separate product
- periodic updates.

4. GEIA project teams are international and intercontinental in make-up.

Achievements and Plans

GEIA's achievements over the past decade include:

- a core of dedicated participants
- more than two dozen projects and many completed and available inventories
- the GEIA Web Site
- eleven international planning workshops
- a growing user community
- expanding links to related efforts.

These achievements all contribute to building a strong and solid foundation for the future of GEIA. The dedicated core teams, successful projects, establishment of a web site, long-term planning enhanced by frequent international workshops, increasing attention to the user-modeling-assessment communities and forward-looking approach to coordination and collaboration all are important elements of GEIA's future.

Convenors and Participants

The first convener of GEIA was Thomas Graedel, now at Yale University. Gregg Marland of Oak Ridge National Laboratory took over as GEIA convener in 1996. In May 1998, Marland was succeeded by co-conveners Derek Cunnold of the Georgia Institute of Technology (USA), and Jos Olivier of the Netherlands National Institute of Public Health and the Environment (RIVM). Including the Coordinating Committee, groups responsible for development of the inventories and active users, there are now over 300 members in the GEIA E-mail Network. Many of the project leaders and Coordinating Committee members have been part of GEIA since its inception in 1990.

Inventory Development Activities

The current status of GEIA inventories is listed below. In the following list of GEIA projects, (A) indicates emissions from anthropogenic sources and (N) emissions from natural sources.

Compounds (available): Ammonia (A), Black Carbon (A), Carbon Dioxide (A), Carbon Monoxide (A), Chlorofluorocarbons (A), Lead (A), Mercury (A), Methane (N), Sulfur and Nitrogen

Oxides, (A), Nitrous Oxide (A& N), Reactive Chlorine Emissions (A&N), Volatile Organic Compounds (A&N)

Compounds (in progress): Methane (A—preliminary version is available through EDGAR web site), Organochlorines (A), Radionuclides (N), Dimethylsulfide (Reduced Sulfur) (N), Primary Particulates (A&N)

Source-Specific Emissions (available): Aircraft Emissions (A), Lightening (N), Nitrogen Oxides in Soils (A), Sulfur from Volcanoes (N)

Source-Specific Emissions (in progress): Biomass Burning (A & N), International Shipping (A)

Other Data (available): Population, Cropland

The recent IGAC Synthesis Report meeting generated more support for several key GEIA data development activities, many of which are already in the GEIA Five-Year Plan which can be reviewed at www.geiacenter.org :

- Inventories for about every 10 years over the past 30-50 years.
- Seasonal cycles in the emissions
- Formulae for the dependence of natural emissions on soil moisture and temperature
- Evaluation of NOX emissions from soils
- Biomass burning emissions given as a function of burning temperature and land use practices
- Combine the GEIA and EDGAR data bases
- Organohalide emissions
- Distinguish between emissions into the canopy and those that reach the global atmosphere

GEIA will be pursuing these and many related activities in the coming months. GEIA also will be developing enhanced QA, expanded formatting and flexible downloading protocols.

The GEIA Center and Outreach Plans

The hub of the worldwide network of scientific agencies and institutions that develop these emissions inventories and the ever-growing user community is the GEIA Data Management and Communication Center. The Center's activities are supported by the National Science Founda-

tion (NSF) and National Aeronautics and Space Administration (NASA) and directed by Paulette Middleton of RAND Environment. The GEIA Center makes GEIA data bases available, manages the center's virtual home at www.geiacenter.org and coordinates the GEIA outreach activities.

As part of the expanded outreach strategy to enhance the exchange of information on GEIA and to encourage participation in GEIA, the GEIA Center recently developed the GEIA Brochure and GEIA Newsletter. The brochure provides a summary of GEIA and is being updated on a regular basis as new projects and other information become available. Each newsletter will have highlights from projects and workshops as well as other timely news related to global emissions inventories. The current brochure and the first newsletter can be found at www.geiacenter.org and can be downloaded in PDF format. This will allow users to print the brochure and newsletter in hard-copy form to be posted or passed on to other interested readers.

In addition to the brochure and newsletter, the GEIA Center is expanding the e-mail network, and establishing more two-way links to related web sites. The Center also is upgrading the web site survey of users and is initiating follow-up discussions with users.

The survey will be similar to the one developed in 1998 to help in the development of GEIA's first 5-year plan. The survey requested information on the user and their use of the GEIA data, their evaluation of the data bases, and more detailed evaluation of specific data sets and needs. The results of the survey have been extremely valuable in developing effective ways to improve the quality and usefulness of GEIA data.

Currently the GEIA Center tracks the number of visitors to the GEIA Web Site, the number and type of downloads, and users' comments regarding their use of the data and their suggestions for GEIA. The results of this tracking are located on the GEIA site. For example, GEIA had 540 downloads of data in 1998 and 704 downloads in 1999. The natural VOC inventory was the most popular download in 1999 and nitrogen oxides was most popular in 1998.

Workshops

Workshops are essential to the continued growth and productivity of GEIA. International workshops on global emissions inventories have been held approximately once each year since GEIA was organized.

The founding meeting of GEIA was organized by Tom Graedal, the first convenor of GEIA, and was held in conjunction with an IGAC conference in Chamonix France in September 1990. The First International Workshop on Global Emissions Inventories was held in conjunction with the CHEMRAWN (Chemical Research Applied to World Needs) meeting in Baltimore, Maryland, USA, in December 1991. The second workshop was held near Oslo, Norway, in June 1992, under the local sponsorship of the Norwegian Institute for Air Research, and the third was held at Amersfoort, The Netherlands, in early 1993, under the auspices of the National Institute of Public Health and Environmental Protection.

The Fourth International Workshop on Global Emissions Inventories was held in late 1993 at the National Center for Atmospheric Research (NCAR) in Boulder, Colorado, USA. A special focus of this workshop was on communication between GEIA inventory developers and atmospheric chemistry modelers. The workshop was scheduled in conjunction with a symposium on "Challenges in Atmospheric Chemistry and Global Change: Yesterday, Today and Tomorrow," held by NCAR to honor Paul Crutzen on his 60th birthday.

The fifth workshop was held in conjunction with the Eighth CACGP Symposium and the Second IGAC Scientific Conference at Fuji-Yoshida, Japan, September 1994. The sixth workshop was held in Gothenburg, Sweden, in July 1995, following the conference "Acid Reign 95?" The seventh workshop was held in Toronto, Canada, May 31-June 2, 1996.

The eighth workshop was held in Bilthoven, The Netherlands, on 3-4 November 1997. The National Institute of Public Health and the Environment (RIVM), the Netherlands governmental agency on the environment hosted it. The GEIA workshop was held back-to-back with the IPCC Expert Meeting on Methods for the Assessment of Inventory Data Quality on 5-7 November 1997. RIVM on behalf of the Netherlands Centre of Climate Research (CKO) and the WAU/DLO Climate Change and Biosphere Research Programme (CCB) cosponsored the IPCC meeting.

The Ninth International Workshop of the Global Emissions Inventory Activity was held at the University of Washington, Seattle, Washington (USA) 19-20 August 1998. It was held back-to-back with the Joint International Symposium on Global Atmospheric Chemistry (CACGP/IGAC 1998 Symposium): Ninth Symposium of the IAMAS Commission on Atmospheric Chemistry & Global Pollution (CACGP) and Fifth Scientific Conference on the International Global Atmospheric Chemistry Project (IGAC).

The 10th GEIA International Workshop was held in Bologna, Italy, on 13 September 1999 in conjunction with the Sixth Scientific Conference of the International Global Atmospheric Chemistry Project (IGAC). The objective of the GEIA Workshop was to provide an opportunity for informal exchange of information about updated inventories and the future direction of the GEIA Web Site between GEIA participants and others interested in global/regional emissions inventories who were attending the IGAC Conference.

The 11th GEIA Workshop is scheduled in conjunction with the workshop on "Emissions of Chemical Species and Aerosol into the Atmosphere", which will take place in Paris, France on June 19-22 2001. The GEIA workshop is planned for June 18, 2001. More details regarding exact meeting time and place, as well as agenda, for the GEIA workshop will appear GEIA web site at www.geiacenter.org. Information on the Emissions Workshop are now available on the POET Web site, http://nadir.nilu.no/poet/international_workshop.htm

CONCLUSIONS

The Global Emissions Inventory Activity (GEIA) will continue to provide scientifically sound, policy-relevant global emissions inventories to the science and policy communities. As global climate change

and regional air quality continue to be pressing concerns worldwide, GEIA will strive to meet the need for highest quality emissions data. GEIA is now in a new phase of revitalization, growth and enhanced responsiveness to an expanding user community. Closer collaboration with atmospheric modelers and other users will continue to be a major focus. To achieve the best possible data bases, users and developer from around the world are encouraged to contact GEIA and become active members in the ever expanding community devoted to developing these highest quality inventories.

REFERENCES

Graedel, T. E., T. S. Bates, A. F. Bouwman, D. Cunnold, J. Dignon, I. Fung, D. J. Jacob, B. K. Lamb, J. A. Logan, G. Marland, P. Middleton, J. M. Pacyna, M. Placet, and C. Veldt (1993): A Compilation of Inventories of Emissions to the Atmosphere. *Global Biogeochemical Cycles*. 7, 1-26.

KEY WORD

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